AIRS/AMSU/HSB Version 5 Level 3 Quick Start

Edited by:
Edward T. Olsen

Contributions by:
S. Granger, E. Manning
Jet Propulsion Laboratory, California Institute of Technology
J. Blaisdell
Goddard Space Flight Center, NASA

August, 2007
Version 1.1

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA

Submit Questions to:
http://airs.jpl.nasa.gov/AskAirs

Table of Contents

Introduction

The V5 Level 3 gridded products are derived from the Level 2 standard swath products. The Level 2 quality indicators determine which of the Level 2 Standard Product data are combined to create the Level 3 Product. It is important that the user of Level 3 Products become familiar with these quality indicators, and we urge the user to read the documentation describing the AIRS Level 2 Standard Products and the AIRS Level 2 Quality Control and Error Estimation for a description of the quality indicators, how they are set and how to use them.

V5_L2_Standard Product_QuickStart.pdf
V5_L2_Quality_Control_and_Error_Estimation.pdf

As a general rule, Level 2 retrieved quantities whose quality indicators are “best” (=0) or “good” (=1) are included in the sums that generate the Level 3 product. Information contained within these two documents will not be repeated in this document, and users **MUST** read them to avoid misuse of the Level 3 products in their research.

TempPresLvls and **H2OpresLvls** are the pressure levels upon which the temperature and moisture products are reported in the Level 3 products. The values (in mb) are provided for convenient reference in the document:

V5_L3_Standard_Pressure_Levels.pdf.

Ascending and Descending Daily, 8-Day and Monthly Products

There are three AIRS Level 3 data products separately derived from MW-Only retrievals and combined IR/MW retrievals: daily, 8-day (one-half of the Aqua orbit repeat cycle), and monthly (calendar). The multi-day products are simply the arithmetic mean weighted by the counts of the daily data combined in each grid box.

Each product is separated into ascending and descending portion of the orbit, where “ascending or descending” refers to the direction of movement of the sub-satellite point in the satellite track at the equatorial crossing. The ascending direction of movement is from Southern Hemisphere to Northern Hemisphere, with an equatorial crossing time of 1:30 PM local time; the descending direction of movement is from Northern Hemisphere to Southern Hemisphere, with an equatorial crossing time of 1:30 AM local time. Outside of the polar zones, these correspond respectively to daytime and nighttime.

Time-Ordering of Gridding

Each Level 3 daily product contains information for a temporal period of 24 hours for either the descending or ascending orbit rather than midnight-to-midnight. The data included in the gridding on a particular day start at the international dateline and progress westward (as do the subsequent orbits of the satellite) so that neighboring gridded cells of data are no more than a swath of time apart (about 90 minutes). The two parts of a scan line that crosses the dateline are included in separate data sets, according to the appropriate date. This ensures that data points in a grid box are always coincident in time. If the data were gridded using the midnight-to-midnight time-span, the start of the day and the end of the day could be in the same grid cell, producing an artificial time discontinuity. The edge of the AIRS Level 3 gridded cells is at the date line (the 180E/W longitude boundary). When plotted, this produces a map with 0 degrees longitude in the center of the image unless the bins are reordered. This method is preferred because the left (West) side of the image and the right (East) side of the image contain data farthest apart in time. The gridding scheme used by AIRS is the same as used by TOVS Pathfinder to create Level 3 products.

The daily Level 3 products will have gores (cells with no data) between the satellite paths where there is no coverage for that day. The 8-day Level 3 products may have missing data due to data dropouts. Monthly Level 3 products will likely contain complete global coverage without gores and with missing data only in locations in which the retrieval algorithm finds to be problematical or where topography intrudes into the lower altitude regime of profiles.

Level 3 files contain geophysical parameters that have been averaged and binned into 1°x1° grid cells. Grid maps coordinates range from -180.0° to +180.0° in longitude and from -90.0° to +90.0° in latitude. For each grid map of 4-byte floating-point mean values there is a corresponding 4-byte floating-point map of standard deviation and a 2-byte integer grid map of counts. The counts map provides the user with the number of points per bin that were included in the mean and can be used to generate custom multi-day maps from the daily gridded products. The complete description of the contents of the AIRS Level 3 Product is available in Appendix A6 of

V5_Released_Proc_FileDesc.pdf

Values of -9999 (if integer) and -9999.0 (if float) or a count of 0 indicate invalid or missing data.

Special Coastline Processing

Atmospheric and surface fields such as surface temperature, and lower tropospheric temperature and water vapor depend on the properties of the surface, specifically whether it is land or ocean/sea. Interpreting infrared and microwave radiances is more complicated over land, and interpreting coastal fields-of-view (FOVs) containing both ocean and land is still more complicated. Because of this, AIRS Level 3 processing sorts input Level 2 retrieval FOVs based on the surface scene type (land or ocean) for the purpose of averaging fields within a grid box.

We developed **LandSeaMask**, a static 1°x1° mask based on the EOS Digital Elevation Map (DEM) where each cell is classified as one of the following 8 types:

Mask	Cell Characterization
0	Shallow Ocean
1	Land Only
2	Ocean/Lake Coast
3	Shallow Inland H2O
4	Ephemeral H2O
5	Deep Inland H2O
6	Continental Shelf Ocean
7	Deep Ocean

A Level 2 retrieval is first classified according to the mask value of the bin into which its centroid latitude/longitude falls as water (mask value = 0,3,5,6,7) or land (mask value = 1,2,4). A threshold test is then applied to its associated **landFrac** to filter out coastline FOVs. If **landFrac** for the FOV falls within the range:

$$0.1 \leq \text{landFrac} < 0.5$$

the FOV is considered to include a coastline and is not included in the generation of the Level 3 product. We do this to avoid mixing land and water in a single grid box. We attempt to maintain separation between land and ocean in the Level 3 gridded product, and a retrieval spanning a coastline is by nature heterogeneous.

Example Level 3 Product File Names

The following examples are Level 3 daily, 8-day and monthly product files for December, 2009. AIRS-Only products will only be released in the event of a failure of AMSU.

Daily Product Dec 3, 2009 processed using AIRS and AMSU radiances:
Name: AIRS.2009.12.03.L3.RetStd001.v5.0.14.0.G2002123120634.hdf
Shortname: **AIRX3STD**

Daily Product Dec 3, 2009 processed using AIRS, AMSU, HSB radiances:
Name: AIRS.2009.12.03.L3.RetStd_H001.v5.0.14.0.G2002123120634.hdf
Shortname: **AIRH3STD**

Daily Product Dec 3, 2009 processed using only AIRS radiances:
Name: AIRS.2009.12.03.L3.RetStd_IR001.v5.0.14.0.G2002123120634.hdf
Shortname: **AIRS3STD**

8-Day Product Dec 3-10, 2009 processed using AIRS and AMSU radiances:
Name: AIRS.2009.12.03.L3.RetStd008.v5.0.14.0.G2002123120634.hdf
Shortname: **AIRX3ST8**

8-Day Product Dec 3-10, 2009 processed using AIRS, AMSU, HSB radiances:
Name: AIRS.2009.12.03.L3.RetStd_H008.v5.0.14.0.G2002123120634.hdf
Shortname: **AIRH3ST8**

8-Day Product Dec 3-10, 2009 processed using only AIRS radiances:
Name: AIRS.2009.12.03.L3.RetStd_IR008.v5.0.14.0.G2002123120634.hdf
Shortname: **AIRS3STD**

Monthly Product Dec, 2009 processed using AIRS and AMSU radiances:
Name: AIRS.2009.12.01.L3.RetStd031.v5.0.14.0.G2002123120634.hdf
Shortname: **AIRX3STM**

Monthly Product Dec, 2009 processed using AIRS, AMSU, HSB radiances:
Name: AIRS.2009.12.01.L3.RetStd_H031.v5.0.14.0.G2002123120634.hdf
Shortname: **AIRH3STM**

Monthly Product Dec, 2009 processed using only AIRS radiances:
Name: AIRS.2009.12.01.L3.RetStd_IR031.v5.0.14.0.G2002123120634.hdf
Shortname: **AIRS3STM**

Level 3 Location Grid

The location grid contains 4 fields each of which are 360x180 element arrays. The elements provide the location and characteristics of the grid cells:

Field Name	Dimension per Grid	Description
Latitude	360x180	Array of latitude values at the centers of the grid boxes (degree)
Longitude	360x180	Array of longitude values at the centers of the grid boxes (degree)
LandSeaMask	360x180	Array of mask values classifying grid boxes (0=ocean; 1=land) (unitless)
Topography	360x180	Array of heights of surface above the geoid (meter)

Level 3 Product Attributes

Level 3 attributes appear once per granule. They provide additional information that is common to all grids and therefore need not be replicated for each grid or grid bin.

Attribute Field Name	Extra Dimensions	Explanation
NumOfDays	None	Total number of days of input Level 2 data included in gridded maps.
AscendingGridStartTimeUTC	None	Begin time of mapped fields (UTC), ascending.
AscendingGridEndTimeUTC	None	End time of mapped fields (UTC), ascending.
DescendingGridStartTimeUTC	None	Begin time of mapped fields (UTC), descending.
DescendingGridEndTimeUTC	None	End time of mapped fields (UTC), descending.
TempPresLvlNum	None	Number of pressure levels associated with temperature profiles and geopotential height.

Attribute Field Name	Extra Dimensions	Explanation
TmpPresLvls	TempPresLvlNum (24)	Standard pressure for each of 24 levels in the atmosphere associated with temperature profiles and geopotential height. The array order is from the surface upward, in conformance with WMO standard. Note that the Level-3 pressure levels are a subset of Level-2 pressure levels and are constrained to begin at 1000.0 mb and end at 1.0 mb. (mb)
H2OPresLvlNum	None	Number of pressure levels associated with AIRS Level-3 water vapor profiles.
H2OpresLvls	H2OpresLvlNum (12)	Standard pressure for each of 12 layers in the atmosphere associated with AIRS Level-3 water vapor profiles. The array order is from surface upward in accordance with the WMO standard. Note that Level-3 pressure levels for water vapor are constrained to be between 1000.0 and 100.0 mb (mb)

Attribute Field Name	Extra Dimensions	Explanation
IREmisFreqs	4	Frequencies corresponding to each of the 4 IR emissivity values reported in the AIRS Level 3 Standard Product. (832.0, 961.0, 1203.0, 2616.0) (cm^{-1})
MWEmisFreqs	3	Frequencies corresponding to each of the 3 microwave emissivity values reported in the AIRS Level 3 Standard Product. (23.0, 50.3, and 89.0) (GHz)
CH4TrapLyrNum	None	Number of trapezoid layers associated with AIRS Level-3 CH4 profiles.
CH4TrapezoidLayers	CH4TrapLyrNum (3)	Trapezoid layers associated with AIRS Level-3 CH4 profiles. (51, 60, 67) (pressSup level indices)
COTrapLyrNum	None	Number of trapezoid layers associated with AIRS Level-3 CO profiles.
COTrapezoidLayers	COTrapLyrNum (7)	Trapezoid layers associated with AIRS level-3 CO profiles. (45, 56, 63, 70, 81, 89, 93) (pressSup level indices)

Level 3 Product Grids

Each Level 3 Product (daily, 8-day and monthly) contains four grids containing fields created using the appropriate Level 2 products whose quality indicators are “best” or “good. The grids are named “ascending_MW_only”, “descending_MW_only”, “ascending” and “descending”. The first pair are created from the MW-Only Level 2 products; the second pair are created from the Level 2 Standard Product arising from the combined IR/MW retrievals. The separation into ascending and descending portions of the orbit mitigates the suppression of the diurnal signal in the data.

Each grid provides a 360x180xn array of the mean, standard deviation and count of Level 2 retrievals combined, where the “extra dimension” n=1 if the product is not a profile. This allows the user to create custom Level 3 products over any desired time span via a simple combination of the published products.

Each grid also provides a 360x180 array of total count of observations, whether included in the calculation of the Level 3 product or not. This provides a measure of the sampling of a reported Level 3 product, but not of the sampling bias.

MW-Only Grids

The ascending_MW_only and descending_MW_only grids are separate, but the table below combines their field descriptions in the interest of minimizing the number of pages in this document. Ascending field names have "_A" appended. Descending field names have "_D" appended. These products do not use any infrared data and are created from the MW-Only Level 2 Standard Products.

MW-Only Product Grid Field Name	Extra Dimensions	Explanation
TotalCounts_MW_A TotalCounts_MW_D	None	Total counts of all points that fell within a 1°x1° grid cell whether they were included in the final L3 product or not. (unitless).
TotH2OVap_MW_A TotH2OVap_MW_D	None	Total integrated column water vapor burden. (kg/m^2)
TotH2OVap_MW_A_sdev TotH2OVap_MW_D_sdev	None	Standard deviation for total integrated column water vapor burden. (kg/m^2)
TotH2OVap_MW_A_ct TotH2OVap_MW_D_ct	None	Number of input points for total integrated column water vapor burden 1°x1° grid cell. (unitles)
EmisMW_MW_A EmisMW_MW_D	3	Microwave spectral emissivity on a frequency grid (23.8, 50.3 and 89.0 GHz). (unitless)
EmisMW_MW_A_sdev EmisMW_MW_D_sdev	3	Standard deviation for microwave spectral emissivity. (unitless)
EmisMW_MW_A _ct EmisMW_MW_D_ct	3	Number of input points for microwave spectral emissivity per 1°x1° grid cell and frequency grid point. (unitless)

MW-Only Product Grid Field Name	Extra Dimensions	Explanation
GPHeight_MW_A GPHeight_MW_D	24	MW-Only geopotential height in meters at 24 standard pressure levels from 1000 to 1.0 mb. (m)
GPHeight_MW_A_sdev GPHeight_MW_D_sdev	24	Standard deviation for microwave-only geopotential height. (m)
GPHeight_MW_A_ct GPHeight_MW_D_ct	24	Number of input points for geopotential height per 1°x1° grid cell and at each pressure level. (unitless)
Temperature_A Temperature_D	24	Microwave-only atmospheric temperature profile in 24 standard pressure levels from 1000 to 1.0 mb. (K)
Temperature_A_sdev Temperature_D_sdev	24	Standard deviation for microwave-only temperature profiles. (K)
Temperature_A_ct Temperature_D_ct	24	Number of input points for temperature profiles per 1°x1° grid cell and at each pressure level. (unitless)

Standard Product Grids

The ascending and descending grids are separate, but the table below combines their field descriptions in the interest of minimizing the number of pages in this document. Ascending field names have "_A" appended. Descending field names have "_D" appended. These products are created from the combined IR/MW Level 2 Standard Products.

Standard Product Grid Field Name	Extra Dimensions	Explanation
TotalCounts_A TotalCounts_D	None	Total counts of all points that fell within a 1°x1° grid cell whether they were included in the final L3 product or not. (unitless).
TotCldLiqH2O_A TotCldLiqH2O_D	None	Mean total integrated column cloud liquid water. (kg/m^2)
TotCldLiqH2O_A_sdev TotCldLiqH2O_D_sdev	None	Standard deviation for cloud liquid water. (kg/m^2)
TotCldLiqH2O_A_ct TotCldLiqH2O_D_ct	None	Number of input points for cloud liquid water per 1°x1° grid cell. (unitless)
TotCldLiqH2O_A_err TotCldLiqH2O_D_err	None	Error estimate of total integrated column cloud liquid water. (kg/m^2)
TotH2OVap_A TotH2OVap_D	None	Total integrated column water vapor burden. (kg/m^2)
TotH2OVap_A_sdev TotH2OVap_D_sdev	None	Standard deviation for precipitable water. (kg/m^2)
TotH2OVap_A_ct TotH2OVap_D_ct	None	Number of input points for precipitable water per 1°x1° grid cell. (unitless)
TotH2OVap_A_err TotH2OVap_D_err	None	Error estimate for total integrated column water vapor burden. (kg/m^2)

Standard Product Grid Field Name	Extra Dimensions	Explanation
TotO3_A TotO3_D	None	Total integrated column ozone burden. (DU)
TotO3_A_sdev TotO3_D_sdev	None	Standard deviation for total ozone. (DU)
TotO3_A_ct TotO3_D_ct	None	Number of input points for total ozone per 1°x1° grid cell. (unitless)
TotO3_A_err TotO3_D_err	None	Error estimate of total column ozone (DU).
SurfAirTemp_A SurfAirTemp_D	None	Temperature of the atmosphere at the Earth's surface. (K)
SurfAirTemp_A_sdev SurfAirTemp_D_sdev	None	Standard deviation for atmospheric surface temperature. (K)
SurfAirTemp_A_ct SurfAirTemp_D_ct	None	Number of input points for atmospheric surface temperature per 1°x1° grid cell. (unitless)
SurfAirTemp_A_err SurfAirTemp_D_err	None	Error estimate of surface air temperature (K).
SurfSkinTemp_A SurfSkinTemp_D	None	Surface skin temperature. (K)
SurfSkinTemp_A_sdev SurfSkinTemp_D_sdev	None	Standard deviation for surface skin temperature. (K)
SurfSkinTemp_A_ct SurfSkinTemp_D_ct	None	Number of input points for surface skin temperature per 1°x1° grid cell. (unitless)
SurfSkinTemp_A_err SurfSkinTemp_D_err	None	Error estimate of surface skin temperature. (K)
SurfPres_A SurfPres_D	None	Mean surface pressure. (mb)
SurfPres_A_sdev SurfPres_D_sdev	None	Standard deviation for surface pressure. (mb)
SurfPres_A_ct SurfPres_D_ct	None	Number of input points for mean surface pressure per 1°x1° grid cell. (unitless)

Standard Product Grid Field Name	Extra Dimensions	Explanation
OLR_A OLR_D	None	Outgoing long-wave radiation flux. (watts/m^2)
OLR_A_sdev OLR_D_sdev	None	Standard deviation for outgoing long-wave radiation. (watts/m^2)
OLR_A_ct OLR_D_ct	None	Number of input points for outgoing log-wave radiation per 1°x1° grid cell. (unitless)
ClrOLR_A ClrOLR_D	None	Clear-sky outgoing long-wave radiation flux. (watts/m^2)
ClrOLR_A_sdev ClrOLR_D_sdev	None	Standard deviation for clear-sky outgoing long-wave radiation. (watts/m^2
ClrOLR_A_ct ClrOLR_D_ct	None	Number of input points for clear-sky outgoing log-wave radiation per 1°x1° grid cell. (unitless)
EmisIR_A EmisIR_D	4	IR surface emissivity on a frequency grid (832, 961, 1203, 2616 cm^{-1}.) (unitless)
EmisIR_A_sdev EmisIR_D_sdev	4	Standard deviation for IR surface emissivity. (832, 961, 1203, 2616 cm^{-1}.) (unitless)
EmisIR_A_ct EmisIR_D_ct	4	Number of input points for IR surface emissivity per 1°x1° grid cell and for each frequency grid point. (unitless)
EmisIR_A_err EmisIR_D_err	4	Error estimate of IR surface □missivity for each frequency grid point.
GPHeight_A GPHeight_D	24	Geopotential height at 24 standard pressure levels from 1000 to 1.0 mb. (m)
GPHeight_A_sdev GPHeight_D_sdev	24	Standard deviation for Geopotential height. (m)

Standard Product Grid Field Name	Extra Dimensions	Explanation
GPHeight_A_ct GPHeight_D_ct	24	Number of input points for geopotential height per 1°x1° grid cell and at each pressure level. (unitless)
CldFrc_A CldFrc_D	None	Combined layer cloud fraction. (0-1). (unitless)
CldFrc_A_sdev CldFrc_D_sdev	None	Standard deviation of combined layer cloud fraction. (unitless)
CldFrc_A_ct CldFrc_D_ct	None	Number of input points for cloud fraction per 1°x1° grid cell. (unitless)
CldFrc_A_err CldFrc_D_err	None	Error estimate of combined layer cloud fraction. (unitless)
CloudTopPres_A CloudTopPres_D	None	Combined cloud top pressure (weighted by cloud fraction). (mb)
CloudTopPres_A_sdev CloudTopPres_D_sdev	None	Standard deviation of combined cloud top pressure. (mb)
CloudTopPres_A_ct CloudTopPres_D_ct	None	Number of input points for cloud pressure per 1°x1° grid cell. (unitless)
CloudTopPres_A_err CloudTopPres_D_err	None	Error estimate of combined cloud top pressure. (millibar)
CoarseCloudFrc_A CoarseCloudFrc_D	3	Cloud fraction at coarse cloud resolution. 3 layers: low, middle, high. (unitless)
CoarseCloudFrc_A_sdev CoarseCloudFrc_D_sdev	3	Standard deviation of coarse cloud layers. (unitless)
CoarseCloudFrc_A_ct CoarseCloudFrc_D_ct	3	Number of input points for coarse fraction per 1°x1° grid cell and at each coarse layer. (unitless)
CoarseCloudTemp_A CoarseCloudTemp_D	3	Cloud top temperature at coarse cloud resolution. 3 layers: low, middle, high. (K)

Standard Product Grid Field Name	Extra Dimensions	Explanation
CoarseCloudTemp_A_sdev CoarseCloudTemp_D_sdev	3	Standard deviation of coarse cloud top temperature. (unitless)
CoarseCloudTemp_A_ct CoarseCloudTemp_D_ct	3	Number of input points for coarse cloud top temperature per 1°x1° grid cell and at each coarse layer. (unitless)
CoarseCloudPres_A CoarseCloudPres_D	3	Cloud layer pressure at coarse cloud resolution. 3 layers: low, middle, high. (mb)
CoarseCloudPres_A_sdev CoarseCloudPres_D_sdev	3	Standard deviation of coarse cloud layer pressure. (mb)
CoarseCloudPres_A_ct CoarseCloudPres_D_ct	3	Number of input points for coarse cloud layer pressure per 1°x1° grid cell and at each coarse layer. (unitless)
FineCloudFrc_A FineCloudFrc_D	12	Cloud fraction at fine cloud resolution. 12 vertical layers. (unitless)
FineCloudFrc_A_sdev FineCloudFrc_D_sdev	12	Standard deviation of fine cloud fraction. (unitless)
FineCloudFrc_A_ct FineCloudFrc_D_ct	12	Number of input points for fine cloud fraction per 1°x1° grid cell and at each coarse layer. (unitless)
RelHumid_A RelHumid_D	12	Relative humidity profile in 12 Standard pressure levels from 1000. to 100. Mb. (per cent)
RelHumid_A_sdev RelHumid_D_sdev	12	Standard deviation for relative humidity profiles. (per cent)
RelHumid_A_ct RelHumid_D_ct	12	Number of input points for relative humidity profiles per 1°x1° grid cell and at each pressure level. (unitless)

Standard Product Grid Field Name	Extra Dimensions	Explanation
H2OVapMMR_A H2OVapMMR_D	12	Water vapor mass mixing ratio at 12 standard pressure levels from 1000. To 100. Mb (gm/kg dry air)
H2OVapMMR_A_sdev H2OVapMMR_D_sdev	12	Standard deviation for water vapor mass mixing ratio. (gm/kg dry air)
H2OVapMMR_A_ct H2OVapMMR_D_ct	12	Number of input points for water vapor mass mixing ratio per 1°x1° grid cell and at each pressure level. (unitless)
H2OVapMMR_A_err H2OVapMMR_D_err	12	Error estimate of water vapor mass mixing ratio at 12 standard pressure levels. (gm/kg dry air)
Temperature_A Temperature_D	24	Atmospheric temperature profile in 24 standard pressure levels from 1000 to 1.0 mb. (K)
Temperature_A_sdev Temperature_D_sdev	24	Standard deviation for Temperature profiles. (K)
Temperature_A_ct Temperature_D_ct	24	Number of input points for temperature profiles per 1°x1° grid cell and at each pressure level. (unitless)
Temperature_A_err Temperature_D_err	24	Error estimate of atmospheric temperature profile at 24 standard pressure levels from 1000 to 1.0 mb. (K)
TropPres_A Trop_Pres_D	None	Pressure of the tropopause. (mb)
TropPres_A_sdev Trop_Pres_D_sdev	None	Standard deviation of the tropopause pressure within the grid box. (mb)
TropPres_A_ct Trop_Pres_D_ct	None	Number of input points for tropopause pressure per 1°x1° grid cell. (unitless)

Standard Product Grid Field Name	Extra Dimensions	Explanation
TropHeight_A Trop_Height_D	None	Height of the tropopause. (m)
TropHeight_A_sdev Trop_Height_D_dev	None	Standard deviation of the height of the tropopause. (m)
TropHeight_A_ct Trop_Height_D_ct	None	Number of input points for tropopause height per 1°x1° grid cell. (unitless)
TropTemp_A TropTemp_D	None	Temperature of the tropopause. (K)
TropTemp_A_sdev TropTemp_D_sdev	None	Standard deviation of the tropopause temperature. (K)
TropTemp_A_ct TropTemp_D_ct	None	Number of input points for tropopause temperature per 1°x1° grid cell. (unitless)
CO_total_column_A CO_total_column_D	None	Retrieved total column CO. (molecules/cm^2)
CO_total_column_A_sdev CO_total_column_D_sdev	None	Standard deviation of total column CO. (molecules/cm^2)
CO_total_column_A_ct CO_total_column_D_ct	None	Number of input points for total column CO per 1°x1° grid cell. (unitless)
CO_total_column_A_err CO_total_column_D_err	None	Error estimate for total column CO. (molecules/cm^2)
CO_VMR_eff_A CO_VMR_eff_D	7	Effective CO volume mixing ratio for 7 trapezoid layers between 45 and 100. (unitless)
CO_VMR_eff_A_sdev CO_VMR_eff_D_sdev	7	Standard deviation of effective CO volume mixing ratio. (unitless)
CO_VMR_eff_A_ct CO_VMR_eff_D_ct	7	Number of input points for effective CO volume mixing ratio per 1°x1° grid cell and at each trapezoid layer. (unitless)

Standard Product Grid Field Name	Extra Dimensions	Explanation
CO_VMR_eff_A_err CO_VMR_eff_D_err	7	Error estimate for CO volume mixing ratio. (unitless)
CO_Verticality_A CO_Verticality_D	7	CO verticality (sum of averaging kernels) at 7 trapezoid layers. (unitless)
CO_Verticality_A_sdev CO_Verticality_D_sdev	7	Standard deviation of CO verticality. (unitless)
CO_Verticality_A_ct CO_Verticality_D_ct	7	Number of input points for CO verticality per 1°x1° grid cell for 7 trapezoid layers. (unitless)
CO_eff_press_A CO_eff_press_D	7	Effective pressure of CO retrieval for each of 7 trapezoid layers. (mb)
CO_eff_press_A_sdev CO_eff_press_D_sdev	7	Standard deviation of CO effective pressure. (mb)
CO_eff_press_A_ct CO_eff_press_D_ct	7	Number of input points for CO effective pressure per 1°x1° grid cell at 7 trapezoid layers. (unitless)
CH4_VMR_eff_A CH4_VMR_eff_D	3	Effective CH4 volume mixing ratio for 3 trapezoid layers between 51 and 73. (unitless)
CH4_VMR_eff_A_sdev CH4_VMR_eff_D_sdev	3	Standard deviation of effective CH4 volume mixing ratio. (unitless)
CH4_VMR_eff_A_ct CH4_VMR_eff_D_ct	3	Number of input points for effective CH4 volume mixing ratio per 1°x1° grid cell and at each trapezoid layer. (unitless)
CH4_VMR_eff_A_err CH4_VMR_eff_D_err	3	Error estimate for CH4 volume mixing ratio. (unitless)

Standard Product Grid Field Name	Extra Dimensions	Explanation
CH4_eff_press_A CH4_eff_press_D	3	Effective pressure of CH4 retrieval for each of 3 trapezoid layers. (mb)
CH4_eff_press_A_sdev CH4_eff_press_D_sdev	3	Standard deviation of CH4 effective pressure. (mb)
CH4_eff_press_A_ct CH4_eff_press_D_ct	3	Number of input points for CH4 effective pressure per 1°x1° grid cell at 3 trapezoid layers. (unitless)

Disclaimer and Caveats for Level 3 Data Products

The user is advised to read the full disclaimer documentation for the V5 Data Products Release:

V5_Data_Disclaimer.pdf

Caveats

Application of Quality Indicators Creates Unequal Numbers of Samples within Profiles and among Retrieved Parameters

The Level 3 products are assembled from Level 2 products that have been filtered using their respective quality indicators. Please refer to the document

V5_L2_Quality_Control_and_Error_Estimation.pdf

for a complete description of the Level 2 quality indicators. Quality control is applied to each data point entering the gridding algorithm both for different parameters and at different levels in the atmosphere for a profile. Therefore the number of samples combined to create the averages varies between parameters and levels in the atmosphere. A result is that profiles will contain different numbers of samples as a function of altitude. There will be a greater number of samples (greater yield) included in the **TairStd** profiles at higher altitudes due to filtering over the pressure regimes using **PBest** and **PGood**. At any particular layer, there will usually be fewer moisture samples than temperature samples because **Qual_H2O** is applied in addition to the relevant temperature profile quality indicator. There will be FOVs containing moisture profiles in which there are layers containing no valid samples but whose associated levels of the temperature profile contain significant numbers of valid temperature samples. Surface fields are filtered using **Qual_Surf**, the most restrictive of the quality indicators. In all cases, a sample is included if the applied quality indicators are either “best” (quality indicator = 0) or “good” (quality indicator = 1).

We provide the count of samples, but this does not characterize sampling biases, which result from the measuring system. For example, parameters that are correlated with cloudiness, e.g. cloud properties and water vapor mass mixing ratio, have sampling biases different from those of the air temperature profile or of the surface parameters. The problem is complicated because the bias is

height and species dependent within a grid box. Water vapor generally has the least restricted quality control applied; hence water vapor associated with less reliable temperature is often included in the averaging despite the fact that its corresponding temperature is not. The rationale for looser quality control on water vapor is that this parameter is sufficiently poorly characterized that a low quality measurement of water vapor is better than none. The loss of sensitivity from clouds is not only dependent upon cloud amount, but depends upon correlations between clouds at different levels that are not characterized by cloud amount alone. Thus you cannot use total cloudiness in a grid box to further quality control the products. At this time we do not recommend analyses be carried out which depend upon correlations between temperature and water vapor fields owing to the field and height dependent quality control used in these products.

Topography Creates Unequal Numbers of Samples within Profiles

Binning vertical profile data over a spatial area containing topography is always problematical. Some samples in a bin may cover a footprint of low altitude topography while others in the same bin may cover a footprint of high altitude topography. This affects the number of samples as a function of altitude of the temperature profile. For example, the number samples falling within an ascending bin, **TotalCounts_A**, is the maximum number of entries which may be used in determining the average air temperature, **Temperature_A**, as some point in the vertical profile. Over topography, the count of samples actually included in the calculation at a particular level, **Temperature_A_ct**, may drop rapidly to zero as the profile approaches the 1000mb level due to intervening topography.

Digitization Effect due to Compression by Rounding

A user who combines data over a time interval to create a histogram of the number of occurrences of a given value of water vapor in the 500-600mb layer will see a high-frequency oscillation. This is a digitization effect due to the compression of the Level 3 data by rounding to shrink the product file size. The precision of H2OMMR is 8 bits in the mantissa. This is equivalent to 2 1/2 significant digits. The effective bin size is ~1/256 of whatever the value is for the given cell. The user has two options to avoid creating a histogram that shows this beating. The first is to make the histogram bin size much larger than the effective bin size. The second is to make the histogram bin size much smaller, but then only display the non-empty bins.

Integrating the Layer Mixing Ratios in H2OVapMMR yields a value smaller than TotH2Ovap

The Level 3 profiles assume the atmosphere extends downward all the way to 1000mb. The Level 3 total water vapor values do not make this assumption. Profiles can extend below the surface, and the user can partially correct for this by using topography to remove from sums of H2OVapMMR layers and fractions of layers that are below the surface. Unfortunately, specific humidity is not constant throughout the vertical extent of a layer so the correction cannot be exact. The user might believe that he is safe over the ocean. However, if the surface pressure is less than 1000mb and the Level 3 bin is over the ocean, the bottom layer should appear to have more water vapor than is really there because it will extend below the surface.